$$\therefore\ x=\frac{a\sin(\theta+\alpha)+b\cos\varphi\sin\alpha-\kappa\cos\alpha}{\sin\alpha\cos\alpha}.$$

$$y=\cos\alpha+\frac{(\kappa-b\sin\varphi)\cos\alpha}{\sin\alpha}=a\cos\theta+b\cos\varphi.$$

$$\therefore\ y=\frac{b\sin(\varphi+\alpha)+a\cos\theta\sin\alpha-\kappa\cos\alpha}{\sin\alpha\cos\alpha}.$$

When $\theta=\varphi=\frac{1}{2}\pi-\alpha$ and $\kappa=\frac{1}{2}(a+b)\sec\alpha$,

$$x=\frac{a-b\cos2\alpha}{\sin2\alpha},\ y=\frac{b-a\cos2\alpha}{\sin2\alpha}.$$

118. **Proposed by L. C. WALKER, A. M.. Graduate Student, Leland Stanford Jr. University, Cal.**

Show how to determine the illumination at any point of the surface of the water at the bottom of a deep well, due to the light from the sky.

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics in The Temple College, Philadelphia, Pa.

Let I=illumination, dQ the quantity of light that falls upon a small area dA of an illuminated surface, coming from an element of any bright surface dS.

Let O be the center of the element of the luminous surface, C the center of the illuminated area dA, and let $OC=r$, depth of well$=a$. Let θ=inclination of OC to normal at O, φ=inclination of OC to normal at C. Now if dA subtend solid angle $d\omega$ at O, and μ be the intrinsic brightness of dS, then

$$dQ=\mu dS\cos\theta d\omega,\ \text{but}\ d\omega=\frac{dA\cos\varphi}{r^2}.$$

$\therefore\ dQ=\mu dSdA\cos\theta\cos\varphi/r^2$.

$\therefore\ I=dQ/dA=\mu\cos\varphi\cos\theta dS/r^2$.

If $d\sigma$ be the solid angle at C subtended by dS, then $d\sigma=\cos\theta dS/r^2$.

$\therefore\ I=\mu\cos\varphi d\sigma$.

The solid angle at C cannot be larger than the top of the well will admit. Let b=the area of the top of well, then we may write $I=\mu b/a^2$ for center of surface of water, since $\theta=\varphi=0$, and $S/r^2=b/a^2$.